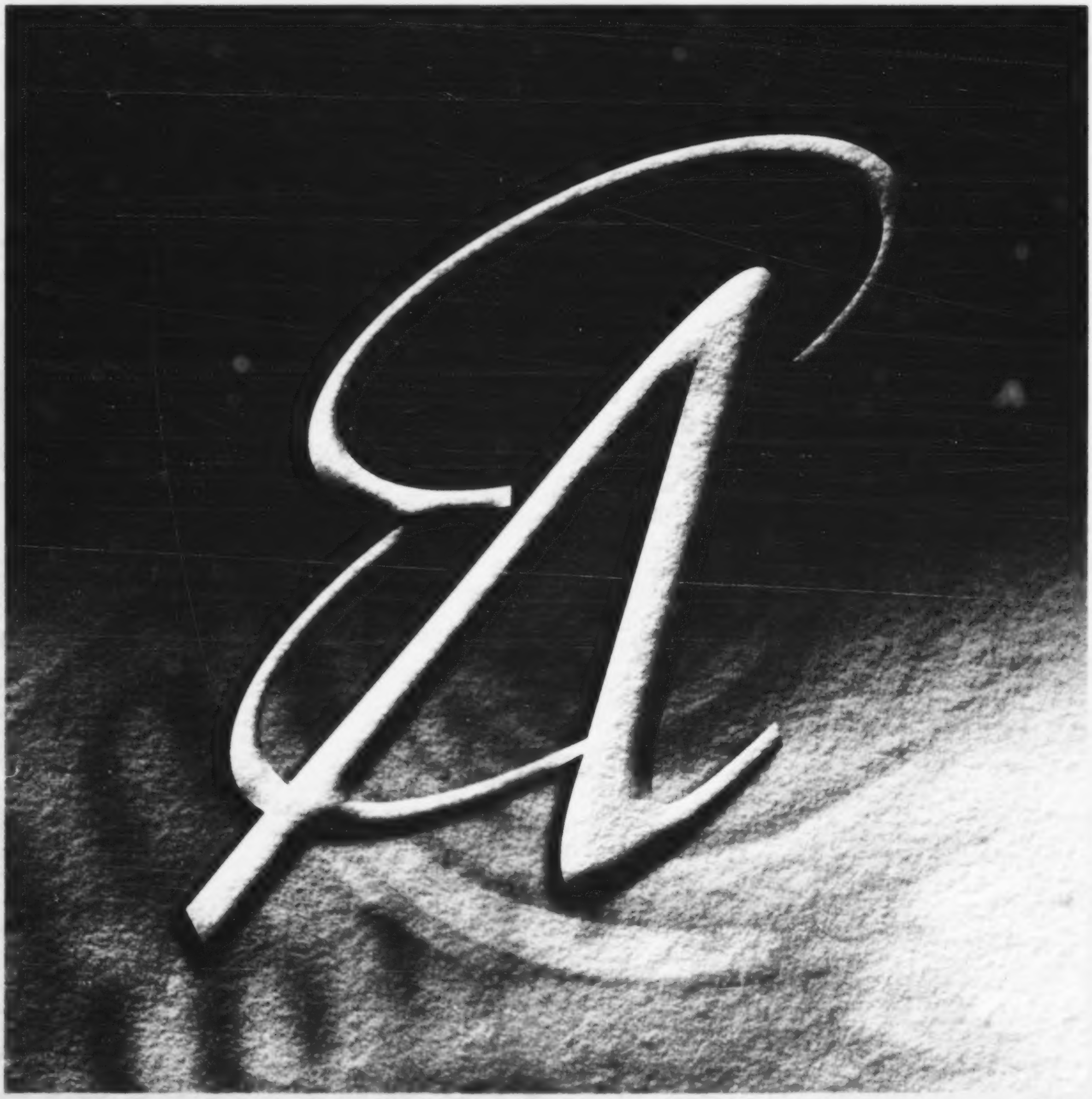
Economic Analysis
Research Paper Series

Plant Size, Nationality, and Ownership Change

by John R. Baldwin and Yanling Wang

No. 060



Statistics Canada Statistique Canada

Canada

Plant Size, Nationality, and Ownership Change

by John R. Baldwin* and Yanling Wang**

11F0027M No. 060
ISSN 1703-0404
ISBN 978-1-100-14900-4

*Statistics Canada
Economic Analysis Division
R.H. Coats Building, 18th floor, 100 Tunney's Pasture Driveway
Ottawa, Ontario K1A 0T6

**Norman Paterson School of International Affairs
Carleton University,
Ottawa, Ontario K1S 5B6

How to obtain more information:
National inquiries line: 1-800-263-1136
E-Mail inquiries: infostats@statcan.gc.ca

February 2010

Published by authority of the Minister responsible for Statistics Canada

La version française de cette publication est disponible (n° 11F0027M au catalogue, n° 060).

Note of appreciation:
Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments, and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

Standards of service to the public
Statistics Canada is committed to serving its clients in a prompt, reliable, and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on www.statcan.gc.ca under "About us" > "Providing services to Canadians."

Economic Analysis Research Paper Series

The Economic Analysis Research Paper Series provides for the circulation of research conducted by the staff of National Accounts and Analytical Studies, visiting Fellows, and academic associates. The research paper series is meant to stimulate discussion on a range of topics including the impact of the New Economy, productivity issues, firm profitability, technology usage, the effect of financing on firm growth, depreciation functions, the use of satellite accounts, savings rates, leasing, firm dynamics, hedonic estimations, diversification patterns, investment patterns, the differences in the performance of small and large, or domestic and multinational, firms, and purchasing power parity estimates. Readers of the series are encouraged to contact the authors with comments, criticisms, and suggestions.

The primary distribution medium for the papers is the Internet. These papers can be downloaded from the Internet at www.statcan.gc.ca for free.

All papers in the Economic Analysis Series go through institutional and peer review to ensure that they conform to Statistics Canada's mandate as a government statistical agency and adhere to generally accepted standards of good professional practice.

The papers in the series often include results derived from multivariate analysis or other statistical techniques. It should be recognized that the results of these analyses are subject to uncertainty in the reported estimates.

The level of uncertainty will depend on several factors: the nature of the functional form used in the multivariate analysis; the type of econometric technique employed; the appropriateness of the statistical assumptions embedded in the model or technique; the comprehensiveness of the variables included in the analysis; and the accuracy of the data that are utilized. The peer-group review process is meant to ensure that the papers in the series have followed accepted standards to minimize problems in each of these areas.

Publications Review Committee
Analytical Studies Branch, Statistics Canada
18th Floor, R.H. Coats Building
Ottawa, Ontario K1A 0T6

Symbols

The following standard symbols are used in Statistics Canada publications:

- . not available for any reference period
- .. not available for a specific reference period
- ... not applicable
- 0 true zero or a value rounded to zero
- 0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
- ^{p} preliminary
- ^{r} revised
- x suppressed to meet the confidentiality requirements of the *Statistics Act*
- ^{E} use with caution
- F too unreliable to be published

Acknowledgement

The authors are indebted to Bob Gibson who prepared the database used herein and to Ryan Macdonald and Beiling Yan for advice on econometrics—especially on the correct way to calculate interaction effects in probit models.

Table of contents

Abstract **7**

Executive summary **9**

1 Introduction **11**

2 Background **11**

3 The analytical framework **14**

3.1 The basic framework 14

3.2 The variables 15

3.3 Estimation strategy 17

4 Data description **19**

5 Regression results **21**

5.1 Baseline results 21

5.1.1 Nationality 21

5.1.2 Plant level characteristics 21

5.1.3 Plant-change variables 22

5.1.4 Industry characteristics 23

5.2 Differences in factors leading to ownership changes between foreign- and Canadian-owned plants 23

6 Conclusion **26**

References **39**

Abstract

This paper asks whether synergies or managerial discipline operates in different ways across small versus large plants to affect the likelihood of mergers. Our findings indicate that those characteristics which provide the type of synergies upon which ownership changes rely are important factors leading to plant-ownership changes across most size classes. The magnitudes, however, are different across plant-size classes, with synergies generally being more important in larger plants.

Foreign plants in all size classes are more likely to be taken over. The effective rates of control change differ much more in the small than in the larger size classes. Compared to domestic plants, multinational plants in the smaller size classes contain relatively more of the type of intangible capital that makes them attractive vehicles for the transmission of new knowledge via takeover.

JEL codes: F23, L25

Keywords: plant size, ownership changes, mergers, foreign ownership

Executive summary

This paper examines the determinants of mergers across plant-size classes by comparing changes in domestic and foreign control in the Canadian manufacturing sector. It uses a sample consisting of all Canadian manufacturing plants operating within the period from 1973 to 1999 and splits the sample into plant-size quartiles for each industry.

This paper asks two questions:

1) **Are the same forces at work across all size classes, or is there a discernible pattern suggesting systematic differences between large and small plants?**

   The plant characteristics that are postulated to drive synergies are equally important or more important in the larger size classes.

   The effect of plant size itself is about the same across the first three plant-size classes. As plant size increases within each of these size groups, the probability of takeover increases monotonically.

   Size is not the only synergistic characteristic whose importance increases across size classes. The effect of embedded knowledge in non-production workers also is greater for larger plant sizes.

   Factors such as industry human-capital intensity and industry profitability/capital intensity both provide additional synergy for plant takeovers, regardless of plant-size group, and the importance of these characteristics often increases across size classes. When acquiring firms focus on industry characteristics as a rough signal that plants provide the type of capacity that permits the transfer of knowledge, it is the larger plants that are sought within these industries by the acquirers.

   In addition to the factors related to synergies, several other characteristics reinforce the tendency for a higher probability of control changes in large plants. Unrelated plants in the largest size classes are more likely to be divested. A less competitive environment is also more likely to see control changes occurring in larger plants.

2) **Are there systematic differences between domestic and foreign plants that suggest different forces are at work in the two sectors?**

   The probability of takeover for foreign-controlled plants is higher across all size classes. Differences between foreign and domestic plants are particularly large in the smallest size classes. These differences in the probability of takeover result partially from differences in plant characteristics (i.e., knowledge intensity) that make a foreign plant a more likely candidate for takeover.

   There are significant differences in the way in which some characteristics affect control changes in the foreign population as opposed to the domestic population. Declines in market share and wages, lead to a greater probability of takeover in the foreign sector, but not in the domestic sector. Foreign operations are more likely to respond to managerial failure by being divested.

In contrast, domestic plants are more likely to be divested if they are younger and have had a growth spurt in sales. Divestiture here appears to be more related to a process that harvests success at an early stage of life by the divesting plant.

1 Introduction

Our earlier paper (Baldwin, Gibson and Wang 2009), asked whether it was synergies or managerial discipline that operate to affect the likelihood of mergers for Canadian manufacturing plants. It found that both synergies and managerial discipline are important. This paper extends that work in order to determine whether these forces are at work equally in different parts of the plant-size distribution.

This paper examines the determinants of mergers across size classes by comparing domestic and foreign control changes in the Canadian manufacturing sector. The primary focus is on differences across size classes because of what that tells us about the importance of this form of renewal in industrial populations.

Renewal by control change is much more common in larger firms. By examining differences across size classes, this study asks whether the same forces are at work in all size classes, but attenuated in the smaller size classes of the population, or whether there is a very different process at work in the largest group of producers. Understanding the differences in the determinants across size classes also helps us understand differences in previous studies that differ in the sample of firms used to analyze the determinants of control changes.[1]

Our second focus is on differences between domestic and foreign plants, because of what this tells us about the impact of the characteristics distinguishing foreign and domestic plants from each other and if failure to account for these differences obscures the processes at work in takeovers. One explanation of mergers relies on the notion that they are the mechanism through which knowledge capital is transferred. Knowledge capital is often non-codifiable, subject to asymmetric information difficulties, and not easily handled through arm's-length transactions. One theory of multinationals is that knowledge transfers across national boundaries are accomplished through acquisition of complementary vehicles—that is in plants with synergistic characteristics that enable the knowledge that is transferred through control changes to be best exploited. This theory of multinational firms suggests they will be different from other plants, and are more likely to be candidates for control changes. Whether the difference increases across size classes depends on whether the knowledge capital increases more rapidly in the foreign than in the domestic sector, as size class increases.

Assessing how different plant characteristics are associated with control changes is done here using a large and comprehensive administrative database that covers almost the entire Canadian manufacturing sector over a long period of time—1973 to 1999.

2 Background

Plant-control change—the transfer of plant ownership from one owner to another, affects a relatively large portion of production in the Canadian manufacturing sector. Between 1973 and 1999, 5.8% of manufacturing shipments are affected by control changes, annually (Table 1). Plant-control changes occur in both foreign-owned and domestic-owned plants.[2] The rates for

1. McGuckin and Nguyen (1995) suggest that the determinants of merger activity across size classes differ and that other studies (i.e., Lichtenberg and Siegel 1992) that rely on a subset of only large firms provide results that are particular only to this group.
2. In this study, the terms domestic-owned and Canadian-owned are used interchangeably.

plant-control change in foreign-owned plants are higher than in Canadian-owned plants. Some 6.7% of plants undergo control changes in the foreign-controlled sector annually, compared to 1.7% in the Canadian-controlled sector (Table 2).

Foreign ownership in the Canadian manufacturing sector is significant and has been relatively stable over the study period. Between 1973 and 1999, the percentage of shipments in the manufacturing sector controlled by foreign plants remained around 45%. While it dipped slightly in the middle of the period (in response to a regulatory regime that placed more restrictions on foreign direct investment), it regained earlier levels by the end of the period (Baldwin and Gellatly, 2005). Foreign-controlled plants tend to be larger than average: foreign multinationals control 12% of total number of plants (Table 2), but they control about 44% of total manufacturing shipments (Table 1).

Plant-control changes are more likely to occur in large plants than in small plants. From 1973 to 1999, 5.8% of manufacturing shipments (Table 1), but only 2.3% of plants are affected annually by plant-control changes (Table 2). When the sample is divided according to owning firms' nationality, plant-control changes affect about 6.5% of manufacturing shipments and 6.7% of plants annually in foreign-owned affiliates. In the Canadian-owned sector, plant-control changes affect 5.8% of manufacturing shipments, and 1.7% of plants. Plant-control changes occur in all plant-size classes, though more frequently in larger plant-size groups: on average, annual ownership changes accounted for only 0.7% of total observations in the smallest plant-size class, while it climbed to 4.7% in the largest plant-size-class (Table 2).

Foreign-controlled plants operate in all plant-size classes in Canada, but are more prevalent in larger plant-size classes: the percentage of foreign-controlled plants is only 4.0% in the smallest plant -size class, and it reaches 23.8% in the largest plant-size class. On average, foreign-owned plants are larger than Canadian-owned plants: foreign-owned plants control about 44% of manufacturing shipments in the smallest plant-size group, with only 4.0% of plants. Similar differences are observed in all other plant-size classes.

While the incidence of control change increases across size classes, differences are larger for domestically-controlled plants. For Canadian-owned plants, the incidence of plant-control change is 0.5% in the smallest plant-size class and 3.9% in the largest plant-size class. For foreign-owned plants, the incidence of plant-control change increases from 5.9% in the smallest plant-size class, to 7.2% in the largest plant-size class. The numbers suggest that size class is positively related to the probability of control change, but nationality is even more important, indicating that size motivations for mergers across plant-size groups are different across ownership types of plants.

The literature has generally found that plant size significantly influences a plant's chances of ownership change (McGuckin and Nguyen, 1995, for example). Two themes are found in the literature on mergers that suggest a relationship between control changes and plant size. The first relates to the synergy hypothesis: that argues large plants are more likely to contain the type of capabilities that permit knowledge capital to be successfully transferred and exploited by the acquiring firm in a new market. The second theme is that entry into concentrated markets is more likely to be accomplished via entry by acquisition than by greenfield plant construction.

While size is often noted as being related to control change, little is known about how the factors leading to plant-control changes vary between small and large plants, and between foreign- and Canadian-owned plants across size classes. This paper tries to fill that gap, especially regarding plant-ownership types. Plant size can be viewed as a general proxy for plant capabilities. When plants get larger, they tend to have more non-production workers to coordinate increased needs of management, produce more products to take advantage of economy of scope, possess

greater capital intensity and use different types of technologies. As a result, it is reasonable to associate an increase in plant size with an increase in plant capability. Asking how measurable factors (like knowledge intensity, number of products, plant age, etc.,), influence the probability of control change in different size classes allows us to assess whether these capabilities are equally important for all size classes or only in the largest size classes. It is possible, for instance, that potential for growth synergies is more important in the smallest or the intermediate size groups, or that the potential from synergies is exhausted before a plant becomes the largest in its industry, thereby leading to nonlinear effects of plant size on plant-control changes.

Other motivations leading to ownership changes, such as those related to the disciplinary hypothesis, might also be different across size classes (Matsusaka 1993a, 1993b; McGuckin et al. 1998). The disciplinary hypothesis suggests that a failing firm is more likely to undergo a control change when markets experiment to see if there are other managers who can make better use of its assets. These factors might not operate with equal intensity across all size classes, if the difficulty of turning a failing firm around differs across firms of different size classes.

Even within each size class, there are reasons to believe that different motivations or factors lead to control changes in foreign- and Canadian-owned plants. Baldwin and Gu (2005) find that foreign-owned plants differ substantially from Canadian-owned plants: they tend to be more productive, pay higher wages and be more innovative because of some special capabilities.[3] Foreign-owned affiliates, being part of foreign multinational enterprises, may enjoy significant advantages over many Canadian-owned plants—they may have greater access to more advanced technologies developed by their parent multinational firms, overseas financial markets, overseas markets for their products, and better management skills. These advantages come from the possession of intangible assets, which are not completely measured by the plant characteristics that will be used in this study. While size may be a good proxy for the general capabilities of Canadian-owned plants, it may not be closely related to the attraction offered by the intangible assets embedded in foreign-owned plants. Acquirers who target capable plants in order to develop synergies might favour foreign-owned plants simply because of what nationality reveals about competencies. Whether the difference between foreign and domestic plants varies across size classes reveals whether the unobserved capital in the foreign-owned sector is greater in the smallest or the largest plants.

It should be noted that being a foreign-owned plant may be a double-edged sword. Although foreign-owned plants may enjoy advantages over domestic-owned plants, in terms of intangible capital, there are several reasons to suppose that they may run a higher 'risk' of being divested because of poor performance, especially when the macroeconomic environment is unfavourable. First, foreign-owned plants may be less likely to adapt to local volatility. Management teams in foreign-owned affiliates might be less familiar with the local business culture; it might take them longer to get a stable customer base; there may be less favourable treatment for R&D support from host governments. Second, the profit cut-off set by their parent firms might be much higher than for domestic-owned plants. Both these factors have led some to hypothesize that foreign plants may have a higher probability of being divested because of failure, and thus, a higher rate of ownership changes.[4] Thus, signals of failure might be more closely related to ownership changes in foreign-owned plants. Indeed, using earlier data, Baldwin and Caves (1991) find evidence to suggest that mergers involving foreign and Canadian plants are characterized by different results and may be caused by different factors.

---

3. Similar results have been reported for the U.S. (Doms and Jensen, 1998), for the U.K. (Conyon et al., 2002), and for Indonesia (Takii, 2004).
4. See Caves (1996).

Separating plants into foreign- and Canadian-owned across plant-size classes provides the opportunity to disentangle the potential differences in ownership changes arising from plant size and ownership differences. Canadian data gives us the opportunity to examine the issue, as Canada is a small, open economy. Foreign-owned affiliates have a large presence in Canada and operate in all manufacturing industries.

This paper relates to a larger body of literature on causes of plant-control changes, which has offered several different frameworks that inform our empirical investigation. The *managerial-discipline* approach (Meade, 1968) treats takeovers and mergers as a form of natural selection, resulting in the replacement of mediocre management. Takeover targets will be, because of entrenched management control or unforeseen events, among the less efficient. Lichtenberg and Siegel (1987, 1990) develop a variant of the managerial-discipline framework and propose a *matching theory* hypothesis, arguing that changes in ownership are driven by enterprises that are looking for a better "match" to improve their performance, and that plants with sub-par performance are likely to be candidates for takeover.

The literature does not restrict itself to the argument that all ownership changes are driven by the managerial-discipline motivations. Firms are also seen to merge in order to create a new hierarchical group whose value, because of synergies, is greater than the sum of the values of the independent firms—McGuckin and Nguyen (1995), McGuckin, Nguyen and Reznek (1998) and Nguyen and Ollinger (2006). Central to these discussions is the assumption that the difference in the characteristics of a plant and some 'average' value across the entire distribution provides a signal of the degree of 'inefficiency' or 'synergy' available to be corrected or exploited via a control change. The notion that takeover targets are likely to possess certain assets that facilitate knowledge transfer is relevant to both foreign and domestic firms.

The remainder of the paper is organized as follows. Section 3 discusses the analytical framework used to investigate the factors related to control changes. Section 4 describes the data used. Section 5 reports the results. Section 6 concludes the paper.

3 The analytical framework

3.1 The basic framework

Our objective is to examine the characteristics of divested or acquired plants in order to shed light on the underlying causes of plants' control changes. Acquirers are assumed to search for potential targets based on some metric (profits, increase in product line, etc)—here we use a composite term referred to as value *v*. Suppose that a plant's value is determined by a combination of plant characteristics and industry-level metrics. Let the value of plant *i* at time *t* be defined as:

$$v_{it} = \beta X_{1,it} + \gamma X_{2,jt} + \varepsilon_{it} \tag{1}$$

where X_1 is a vector of plant-specific attributes of plant *i* at time t, X_2 is a vector containing industry characteristics where the plant operates (indexed by *j*), and ε is a random-error term capturing unobserved influences. Acquirers choose to acquire plant *i* at a given point in time if the expected value is greater than a critical level, say, ϖ_{it}. The probability of a plant being acquired is defined as the probability that $v_{it} \geq \varpi_{it}$.

$$\Pr(OC=1)=\Pr(\beta X_{1,it}+\gamma X_{2,jt}+\varepsilon_{it}\geq\varpi_{it}) \quad (2)$$

where *OC*=1 denotes an ownership change, and 0 otherwise. Rewriting (2) leads to,

$$\Pr(OC=1)=\Pr(\beta X_{1,it}+\gamma X_{2,jt}\geq\varpi_{it}-\varepsilon_{it}) \quad (3)$$

Assume that $(\varpi_{it}-\varepsilon_{it})\sim N(\mu_t,\sigma^2)$, then equation (3) can be re-written as:

$$\Pr(OC=1)=\Pr(\varpi_{it}-\varepsilon_{it}\leq\beta X_{1,it}+\gamma X_{2,jt})=\Phi\left(\frac{\beta X_{1,it}+\gamma X_{2,jt}-\mu_t}{\sigma}\right) \quad (4)$$

where β and γ are constants, and μ_t is year-specific constant, such as the year dummy, and Φ is the cumulative normal distribution. Equation (4) can be estimated using a probit model. The variables used in the estimation are outlined below. In particular, plant-specific variables *X* can be split into two groups—a plant's longer-run performance (variables in levels) and its short-run performance just prior to the ownership change (variables in changes).

3.2 The variables

The set of variables used here is taken from Baldwin, Gibson and Wang (2009) and is summarized here.

The first set of variables relates to the *level* of certain plant characteristics. These variables capture the extent to which certain types of assets are chosen for synergy.

Rel_L: a plant's size, in terms of total employment relative to its Standard Industrial Classification (SIC) four-digit industry mean, averaged over the previous three years. *Rel* stands for *relative*.[5] The three-year average is used to smooth out annual fluctuations in a plant's relative performance. Relative plant size is a general proxy for the types of competencies that allow some plants to grow larger.

Rel_NL: a plant's ratio of non-production workers to total workers, relative to its SIC four-digit industry mean, averaged over three years (a proxy of a plant's knowledge intensity).

Product: number of products produced—a measure of a plant's product diversification, which is derived from a Herfindahl measure of a plant's diversification.[6] This variable captures the potential for scope economies at the plant level.

Age: as an older plant builds up experience and knowledge from cumulative production experience, *age* is expected to have a positive sign.

---

5. We make use of our variables in relative form to deal with the lack of special price data for each plant. A similar methodology is employed in Christensen, Cummings and Jorgenson (1981), Olley and Pakes (1996), Dhrymes and Bartlesman (1992), Baily, Hulten and Campbell (1992), Baldwin (1992), McGuckin and Nguyen (1995).
6. See Baldwin, Beckstead and Caves (2002) for a study of plant-level diversification and a discussion of the Herfindahl measure of product diversification.

Plant1961: approximate age of a plant built before, or in, 1961. Because of the lack of information on their actual birth year, we take year 1961 as their starting year.

Unrelated: a binary variable to capture related or unrelated merger/acquisition. It takes on the value of 1 if the acquired plant is owned by a firm whose primary activity is in another four-digit industry and 0 otherwise. Firms often expand across industry boundaries—as part of a diversification process. These mergers tend to be the least successful (Lecraw 1984).

Foreign: a binary variable taking on the value of 1 if a plant is foreign-owned and 0 otherwise. Ceteris paribus, a foreign-owned plant is more likely to contain the type of knowledge capabilities that allow for transfer of new knowledge via takeovers.

The second set of variables captures a plant's short-run performance and is meant to allow us to assess the importance of factors related to managerial discipline across size classes. Each of these change variables is measured relative to the four-digit industry mean of the industry in which the plant is located, and is defined as the difference between the performance in the present period and in the previous year.

Δ*Rel_NL*: change in a plant's ratio of non-production to total workers—a measure of change in the knowledge capabilities of the plant.

Δ*Rel_L*: change in a plant's employment size—a measure of the change in market share. Reductions in relative employment are an indication of a loss in market share.

Δ*Rel_WR*: change in a plant's wage rate—a measure of the change in a plant's ability to compete in labour markets. Reductions in relative average wage rates provide a signal that plants are losing their competitiveness.

Δ*Rel_PR*: change in a plant's profit rate (value added[7] minus wages and salaries, divided by value added)—a measure of change in the plant's profitability. Reductions in profits directly affect shareholders' financial well-being.

The third set of variables are industry characteristics that control for the fact that some industries contain more of the types of plants offering greater synergy possibilities (when new knowledge emerges) than types of plants offering gains from consolidation. The industry variables here are defined at the four-digit SIC80 industry level. Baldwin and Caves (1991) argue that certain industries (science-based and scale-based), contain plants whose knowledge is embedded in the plant and where control change is the method by which new knowledge is best combined with old knowledge. These industries therefore may be more prone to control changes, in that they offer a signal that their plants facilitate knowledge transfer.

We include industry characteristics such as relative industry plant size—*Ind_L*, relative industry non-production worker (knowledge) intensity—*Ind_NL*, relative industry wage rate—*Ind_WR*, and relative industry profit rate, which on a cross-sectional basis, proxies capital intensity—*Ind_PR* (industry level value added, minus wages and salaries, divided by value added). In each case, the industry characteristic is measured relative to the manufacturing average.

7. Value added is the value of sales minus the value of purchases of intermediate goods and services.

In addition, we include an industry variable that captures the number of plants in an industry—*Ind_Plant*. This is meant to measure the intensity of competition in an industry—or the ease of entry into an industry through the alternate means of greenfield plant creation. The number of plants in an industry is inversely related to the difficulty of entry and expansion via plant creation. Where there are few plants, entry is more likely to be accomplished via takeover than by greenfield expansion since takeover has less of an effect on capacity, and therefore less of a depressing effect on prices.

Finally, we recognize that there may be some industry effects that are still not captured with the above industry characteristics, and so we include a set of industry binary variables. We inform our choice of sectors from previous research by dividing the four-digit industries into five major groups. They are: natural-resource based—*Ind1*, labour intensive—*Ind2*, scale-based—*Ind3*, product-differentiated—*Ind4*, and science-based industries—*Ind5*.[8] Each group is defined primarily on the basis of the factors influencing the process of competition.

With the variables defined, our baseline estimation equation is:

$$
\begin{aligned}
&\Pr(OC_{it}=1)=\Phi\left(\alpha+\beta^{f}\, Foreign+X\beta\right)\\
&\Pr(OC_{it}=1)=\alpha+\beta^{F} Foreign_{it}+\beta^{NL} Rel\_NL_{it}+\beta^{L} Rel\_L_{it}+\beta^{Age} Age_{it}+\beta^{D} Plant1961_{it}\\
&+\beta^{Prod} Product_{it}+\beta^{unrel} Unrelated_{it}+\beta^{\Delta NL}\Delta Rel\_NL_{it}+\beta^{\Delta L}\Delta Rel\_L_{it}\\
&+\beta^{\Delta WR}\Delta Rel\_WR_{it}+\beta^{\Delta PR}\Delta Rel\_PR_{it}+\beta^{IndP} Ind\_Plant+\beta^{IndNL} Ind\_NL_{jt}\\
&+\beta^{IndL} Ind\_L_{jt}+\beta^{IndWR} Ind\_WR_{jt}+\beta^{IndPR} Ind\_PR_{jt}+\sum_{w=1}\lambda_w Ind_w+\sum_{y=1}\theta_y Year_y+\varepsilon_{it}
\end{aligned}
\tag{5}
$$

Since one of our central interests is to study whether causes leading to plant ownership changes differ systematically between foreign- and domestic-controlled plants, we introduce interaction terms between *Foreign* and all other major covariates. With the interactions terms, the estimation equation becomes:

$$\Pr(OC_{it}=1)=\Phi(Z\eta)=\Phi\left(\alpha+\beta^{f}\, Foreign+X\beta+\ \delta\, Foreign*Y\right) \tag{6}$$

where Y is a subset of X (can be a full set of X as well). If not written in the matrix form, for example, the coefficient, δ^{F_NL}, stands for the coefficient on the interaction term, *Foreign*Rel_NL*. That is, the first part of the superscript *F_* stands for the interaction of a particular variable with *Foreign*. The coefficients on interactions between *Foreign* and other variables are similarly coded.

3.3 Estimation strategy

In order to compare the impact of different plant characteristics across size classes, we make use of estimates of marginal probability effects. In our case, estimation of the marginal effects requires the assessment of the impact of a dummy variable (*Foreign*), interacted with other continuous variables (such as *Rel_NL*). In the case of an interaction term involving one continuous variable and one dummy variable, the marginal effects for the interaction term is the discrete difference, with respect to the dummy, of the single derivative with respect to the

8. See Baldwin and Rafiquzzaman (1994) for a discussion of the methodology used to create these groupings.

continuous variable (Norton, Wang and Ai 2004). We take the interaction term *Foreign*Rel_NL* to illustrate the point. Its marginal effects are defined as:

$$\frac{\Delta\left(\frac{\delta\Phi(Z\eta)}{\delta Rel\_NL}\right)}{\Delta Foreign}=\frac{\delta\Phi(Z\eta)}{\delta Rel\_NL}|_{Foreign=1}-\frac{\delta\Phi(Z\eta)}{\delta Rel\_NL}|_{Foreign=0} \tag{7}$$

First, the derivative of $\Phi(Z\eta)$ with respect to *Rel_NL* is:

$$\frac{\delta\Phi(Z\eta)}{\delta Rel\_NL}=\Phi^{'}(Z\eta)*\left(\beta^{NL}+\delta^{F\_NL}Foreign\right) \tag{8}$$

The above derivative evaluated at Foreign=1 (the foreign-owned plants subgroup) is:

$$\frac{\delta\Phi(Z\eta)}{\delta Rel\_NL}|_{Foreign=1}=\Phi^{'}\left(\alpha+\beta^{F}+X\beta+\delta Y\right)*\left(\beta^{NL}+\delta^{F\_NL}\right) \tag{9}$$

where the means of *X* and *Y* are taken from the population of foreign-owned plants.

The derivative in equation (8) evaluated at Foreign=0 (Canadian-owned plants subgroup) is:

$$\frac{\delta\Phi(Z\eta)}{\delta Rel\_NL}|_{Foreign=0}=\Phi^{'}(\alpha+X\beta)*\beta^{NL} \tag{10}$$

where the means of *X* are taken from the population of Canadian-owned plants.

Thus, the marginal effect of the interaction term, *Foreign*Rel_NL* is the difference between equations (9) and (10):

$$\begin{aligned}\frac{\Delta\left(\frac{\delta\Phi(Z\eta)}{\delta Rel\_NL}\right)}{\Delta Foreign}&=\Phi^{'}\left(\alpha+\beta^{F}+X\beta+\delta Y\right)*\left(\beta^{NL}+\delta^{F\_NL}\right)-\Phi^{'}(\alpha+X\beta)*\beta^{NL}\\&=\Phi^{'}\left(\alpha+\beta^{F}+X\beta+\delta Y\right)*\delta^{F\_NL}+\left(\Phi^{'}\left(\alpha+\beta^{F}+X\beta+\delta Y\right)-\Phi^{'}(\alpha+X\beta)\right)*\beta^{NL}\end{aligned} \tag{11}$$

It is evident that even if the probit coefficient on the interaction term, δ^{F_NL}, is zero, we can still have a non-zero marginal effect provided the difference $\left\{\Phi^{'}\left(\alpha+\beta^{F}+X\beta+\delta Y\right)-\Phi^{'}(\alpha+X\beta)\right\}$ or β^{NL} is not zero. Similarly, the significance level of the marginal effects also depends on β^{NL}, and it is possible that even if δ^{F_NL} is significant, the associated marginal effects may not be.

The marginal probability effects of the interaction terms between *Foreign* and other continuous variables, and the marginal effects of other continuous variables for Canadian-owned plants (base results) are similarly derived. In the case of a product involving two dummy variables, such as *Foreign*Unrelated*, the marginal effects of the interaction term is the discrete double difference (Norton, Wang and Ai. 2004):

$$
\begin{aligned}
&\frac{\Delta\Phi(Z\eta)}{\Delta Foreign\ \Delta Unrelated}=\frac{\Delta\left\{\Phi(Z\eta)|_{Foreign=1}-\Phi(Z\eta)|_{Foreign=0}\right\}}{\Delta Unrelated}\\
&=\left\{\Phi(Z\eta)|_{Foreign=1}-\Phi(Z\eta)|_{Foreign=0}\right\}|_{Unrelated=1}\\
&-\left\{\Phi(Z\eta)|_{Foreign=1}-\Phi(Z\eta)|_{Foreign=0}\right\}|_{Unrelated=0}\\
&=\left\{\Phi(Z\eta)|_{Foreign=1,\,Unrelated=1}-\Phi(Z\eta)|_{Foreign=1,\,Unrelated=0}\right\}\\
&-\left\{\Phi(Z\eta)|_{Foreign=0,\,Unrelated=1}-\Phi(Z\eta)|_{Foreign=0,\,Unrelated=0}\right\}
\end{aligned}
\tag{12}
$$

The first difference in equation (12) is the discrete change of the probability for *Unrelated* from 0 to 1 for foreign-owned plants, $\left\{\Phi(Z\eta)|_{Foreign=1,\,Unrelated=1}-\Phi(Z\eta)|_{Foreign=1,\,Unrelated=0}\right\}$, and the second difference is the discrete change of the probability for *Unrelated* from 0 to 1 for Canadian-owned plants, $\left\{\Phi(Z\eta)|_{Foreign=0,\,Unrelated=1}-\Phi(Z\eta)|_{Foreign=0,\,Unrelated=0}\right\}$, which is the base marginal effect.

To estimate the marginal effects for the base (Canadian-owned plants) and the interaction terms for additional marginal effects for foreign-owned plants, we first estimate a probit model, and then, according to the formulae developed above, use 'nlcom' command in Stata to calculate the coefficient and the associated standard error of the marginal effects of the base terms and the interaction terms.

We first estimate the results for the pooled sample in order to obtain an overview of the differences in the factors leading to plant-control changes between foreign- and Canadian-owned plants. But as one of our objectives is to explore how the factors behind plant-control changes vary with plant-size classes, we then split the sample into 4 quartiles. That is, for each industry-year, we group those plants by plant size (based on employment): less than the 25th quartile (1st quartile), those between the 25th and the 50th (2nd quartile), those between the 50th and the 75th (3rd quartile), and those between the 75th and the 100th (4th quartile),into 4 separate sub-samples. We then pool all the sub-samples for all industry-year pairs.

4 Data description

The dataset is the same as that used in Baldwin, Gibson and Wang (2009). Our data are unique in terms of the comprehensiveness of coverage of a population, the length of time covered and the nature and accuracy of firm identifiers that are used to measure control changes. The data come from the Annual Census (now Survey) of Manufacturing (ASM), conducted and

maintained by Statistics Canada.[9] The 1973-1999 file has a constant industry classification over this period, allowing us to study the impact of industry characteristics on a consistent basis.[10]

A longitudinal database has been created from the annual survey data with plant and firm identifiers that allow for detailed studies of population dynamics. We exclude those plants in the groups at the bottom or top 1% of the population for each of the changes in relative plant size and wage rate variables, and exclude those plants in the groups at the top and bottom 2 % for the changes in relative profitability. We also exclude some control changes where there was a data gap in the file (between the divestiture and the acquisition), because of the likelihood that this simply involved a lag in data collection during the time of ownership transition. After doing that, we are left with 416,449 usable observations on the entire set of the variables. Some 12% of observations are foreign-controlled (49,912), while 88% are Canadian-controlled plants (366,537) (Table 2).

There are 9,439 control changes in the sample, and these control changes occur more frequently for domestic-owned plants (6,118 ownership changes) than for foreign-owned plants (3,321). The incidence of ownership changes is 2.3% for the whole sample, while it is 6.7% for foreign-controlled plants, and 1.7% for domestic-controlled plants. Foreign-owned plants are almost 4 times more likely than Canadian-owned plants to change control. The incidence of control changes increases dramatically across size groups—from 0.7% in the first quartile to 4.7% in the fourth quartile—over a 6-fold increase. This is largely driven by the increase in the domestic sector (Table 2).

Foreign-owned plants are significantly different from Canadian-owned plants, even within the same plant-size class. Foreign-owned plants are larger, have a higher percentage of non-production workers and produce more products in each plant (Table 3).

Domestic-controlled plants with ownership changes are significantly larger, have a higher and increasing human capital intensity, produce more product lines, are older, more likely to be found in a four-digit industry different than their parents and are losing their competitiveness in the labour markets, as measured by decreasing relative wage rates (Table 4). In addition, those plants with ownership changes are more likely to be found operating in the four-digit industries with larger plant size, higher human capital intensity, higher wages and higher profitability/ capital intensity.

Similar differences regarding plant-level variables are found in foreign-controlled plants. For plant-change variables prior to takeover, foreign-controlled plants with ownership changes are found to be increasing their human capital intensity, but deceasing their plant size, wage rate and profitability. For the industry-level variables, foreign-controlled plants with control changes are generally found in industries with a lower wage rate and lower capital intensity than those without ownership changes.

9. During the period, the file was essentially a census of all plants—with the smallest plants being covered with administrative tax files. It is only post 2003 that the file has become a sample survey. In the survey, plants are asked the following information: value added, shipments, production workers, non-production workers, nationality of owners, cost of materials, cost of heat and energy, among others.

10. For further descriptions of the file, see Baldwin (1995), Baldwin, Beckstead and Girard (2002).

5 Regression results

We proceed in two steps. In step one, we include only a single intercept binary variable for foreign-controlled plants to allow for differences in the impact of nationality and to estimate a probit model for all observations and for those in each plant-size quartile—baseline results.[11] The impact of all variables (besides the nationality binary variable), is assumed to be similar for both the domestic and foreign populations.

In the second step, we allow all the independent variables to vary between domestic and foreign-controlled plants. We can then examine whether the correlates associated with the probability of mergers (i.e., knowledge intensity), have different signs or magnitude for plants under foreign than domestic control, across size classes.

5.1 Baseline results

Baseline results are estimated assuming the differences between foreign and domestic plants leading to plant-control changes can be summarized with just an intercept. The estimates are reported for each of the four plant-size-classes in the first four columns of Table 5. The fifth column contains the totals for all plants. Hausman tests are performed on each pair of the results across the different size classes. They indicated that the results in each quartile were significantly different from the others.

5.1.1 Nationality

Overall, the probability of takeover for foreign controlled plants is 1.3 percentage points higher than for domestic plants (last column, Table 5). This accords with the view that there are inherent capabilities embedded in foreign controlled plants that enhance their desirability as takeover targets. The higher probability is found across all size classes, suggesting that even smaller multinational plants have access to embedded knowledge of their parents. More importantly, the differential probability of takeover in foreign-controlled plants increases as size gets larger, which accords with the view that the unmeasured capabilities in foreign-controlled plants increase with size.

5.1.2 Plant level characteristics

As was expected, larger plants are more likely to be taken over, which accords with the contention that the size variable captures unmeasured competencies that make a plant more likely to provide complementary knowledge capabilities that provide fertile ground for the incorporation of new knowledge via a takeover. That the effects of plant size are positive in each size class suggests that these competencies increase monotonically across plant sizes: plants grow larger, not only by increasing physical capital, but also by developing the type of competencies that are necessary for incorporating the embedded knowledge transferred via mergers. It is significant that the effect of plant size on competencies does not increase across plant-size groups; rather, the effect is smallest in the largest plant-size class.

Human capital, as measured by non-production-worker intensity, is found to be an important signal of the likelihood of control changes for the overall population. Plants with a larger

11. Quartiles are defined by four-digit SIC.

proportion of non-production workers (*Rel_NL*) and increasing in that capacity (Δ*Rel_NL*), are more likely to experience a change in control. Furthermore, contrary to the coefficient on plant size, the coefficient on the level of human capital increases continuously across plant-size classes increase. Knowledge capital is an important prerequisite of a synergistic takeover. Plants involved in these takeovers provide the foundation into which the new knowledge from the acquirer is embedded. These results suggest that its importance is higher in larger plants. In the largest plants, it is not size in general, but specific competencies related to the non-production work complement, that matter when it comes to the synergies that are required for mergers.

Plant age too, is often regarded as a proxy for general competencies accumulated by a firm over time. In keeping with this theme, age for all plants built after 1961 has a positive and significant coefficient for the pooled sample, but this relationship is not found in any of the three smaller size classes. In fact, it is negative and significant in the small size classes, thereby suggesting that it is the youngest smaller plants that are more likely to be acquired. This is more suggestive of a life-path explanation for mergers—younger, small plants are more likely to undergo control changes, with the relationship to age changing as they get larger. The age variable for plants built before 1961 is also negative in the first quartile, but positive and significant in the largest size classes (in the fourth quartile).

In the pooled sample, plants that are not core to their parents' major business are more likely to be divested, consistent with Lecraw's (1984) finding of poor performance in unrelated diversifiers. Some firms expand to new industries as part of the experimental process associated with dynamics. These experiments are more likely to fail and the plants more likely to be divested. The likelihood of an unrelated plant being divested gets larger for larger plant-size groups. The experimentation errors associated with unrelated diversification in larger plants are more costly and the needs for correction are higher. Ceteris paribus, for a representative plant, not being core to the business of its parent increases its probability of divesture by 0.9 percentage points in the first quartile, and 3.1 percentage points in the fourth quartile.

The number of products is positively and significantly related to the probability of a control change in the overall sample in accordance with the economy of scope theme, but there is very little difference in the coefficients across the first, second and third quartiles, where the coefficient is significant. The economy of scope incentive does not appear to be related to the size class of the plant, suggesting that scope and scale incentives are unrelated.

5.1.3 Plant-change variables

Overall, increases in plant size in the previous year are related to an increased probability of divestiture, acting as a signal of synergistic possibilities, but it is not significant in the overall sample. This signal is strongest and most significant for smaller plants. This is to be expected in a world where entry is regarded as the purchase of an option (Caves, 1998). Only those who discover that their skills are superior will invest and grow. Thus, growth serves as an important signal to potential buyers that those plants are good targets.

Declining wages also serve as a weak signal for takeover for the entire sample. Here, however, the signal is strongest in the second quartile—both in terms of size of coefficient and significance. Losing competitiveness in the labour market is a significant signal that is also restricted to smaller plants, perhaps because it is in the smaller plants that performance turnaround is most likely to be achieved. On the other hand, a decline in profitability is negative and weakly significant in the largest plant-size class, implying that for the largest plants, losing profitability is an important signal that leads to control changes.

5.1.4 Industry characteristics

The number of plants in an industry has a negative and significant impact on the probability of a control change. However, the increase in the probability of takeover, where there are fewer producers, is much higher in the larger plant-size classes. Control changes are more likely to bring in new participants in industries that are more concentrated; but they are more likely to affect the identity of the largest participants in these industries.

Industry-level covariates related to knowledge intensity (proportion of non-production workers), industry human capital intensity (wage rates) and industry capital intensity (profitability) all provide additional synergy for plant takeovers across several of the plant-size groups. The importance of these characteristics generally is higher in the larger size classes. These variables capture signals about members of a population that are derived from the population's average characteristics. When they are used by acquiring firms as a signal that some plants within the size class provide the type of capacity that permits knowledge transfer, it is the largest producers that are more affected. This suggests that the value of this signal increases for larger plant-size classes.

5.2 Differences in factors leading to ownership changes between foreign- and Canadian-owned plants

This subsection examines whether the factors leading to plant-ownership changes provide similar or different signals for foreign-owned plants, as it allows us to delve more deeply into the causes behind control changes. In this paper, we use plant size as a proxy for size of the owning firm because of the connection between size and basic competencies; however, on average, foreign plant size is probably a less perfect measure of the overall firm size for foreign-controlled plants than for domestic plants because of the foreign operations of a multinational. By separating out foreign plants, we potentially remove this problem for the domestic sector. This also allows us to examine how foreign plants differ across the size spectrum, to understand where advantages of the former are particularly large, and to understand the differences between foreign and domestic plants, with respect to the factors leading to ownership change.

To examine the differences in the marginal effects of our explanatory variables in foreign-controlled plants, we add interaction terms between *Foreign* and all other major variables, and calculate the marginal effects for domestic plants as a whole at their mean values[12] and the additional marginal effects for foreign plants at their mean values. The overall results are reported in Table 6, and the results across size classes are reported in Tables 7 and 8. In these tables, we report both probit coefficients and marginal effects. In our exposition, we concentrate on marginal effects because, as we pointed out in Section 3, there can be considerable differences in the significance levels between the probit coefficients and the marginal effects for interaction terms.

We perform Hausman tests on probit coefficients across the four quartiles and on the pooled sample. The test results show that the coefficients in each quartile are significantly different from one another, and significantly different from the pooled sample. In what follows, we will focus our comparisons on the marginal effects. First, we compare the differences in factors between the foreign- and domestic populations within each plant-size group, and then across plant-size groups.

12. The mean is calculated for the sample as a whole with the exception of the foreign binary variable, which is set equal to zero.

Size (*Rel_L*)—When foreign plants are considered separately (Table 6), the impact of size for domestic plants, is positive and significant, while the net impact of foreign plants is not significantly different from zero. Therefore, it is in the domestic sector that this variable better reflects differences in competencies being sought in mergers. This is probably because the size of the multinational plant is less correlated with the overall size of the parent firm.

For Canadian-owned plants, size effects are larger in the three smaller plant-size classes than in the largest plant-size class. For foreign-owned plants, the size effects are generally positive in the small and medium size classes, but are not significantly different from zero in the largest size class. The value of size as a proxy for the competencies needed to transfer knowledge eventually dissipates in both domestic and foreign plants. The pattern in the foreign group suggests that size becomes less important earlier. The differences between the two groups accords with the argument that the size of the multinational plant in Canada is a less perfect predictor of capabilities because a small multinational is more likely than a small domestic plant to have a large parent.

Knowledge intensity (*Rel_NL*)—There is no significant difference overall between foreign plants and Canadian-owned plants with respect to the impact of knowledge intensity (Table 6). For Canadian-owned plants however, the effects become larger with increases in plant-size classes, and the relationship is the reverse for foreign-owned plants.

Age (*Age and Plant1961*)—For the pooled sample, plant age has a positive impact for both Canadian plants and foreign plants, although the age effects are larger for foreign plants (Table 6). Estimating the impact of age by nationality and size class (Tables 7 and 8), we find that younger Canadian plants in the three smallest size classes are more likely to be taken over. This implies that if a domestic plant remains small as it ages, there is a lower likelihood that it will be seen to have the capability to be a candidate to act as a conduit for new ideas via a merger. On the other hand, there is a greater tendency for older foreign plants (in two of the three smaller size classes), to be taken over. It is here that age signifies maturity and capability. In the largest size classes, age of plants born before 1961 has a weak positive impact for both Canadian and foreign-owned plants. The results demonstrate that there are two separate processes at work in the domestic and foreign plant populations.

Product—When the sample is pooled, plants with more products are more likely to be taken over and there is no significant difference between foreign- and Canadian-owned plants, overall (Table 6). However, when the relationship is examined for the four plant-size classes, significant positive scope effects are found to be present for Canadian-owned plants in the first and the second quartiles, but not in the larger size classes. In contrast, it is significantly negative for foreign-owned plants in the smallest plant-size class, positive for the remaining size classes, but only significant in the second plant-size class. Scope economies then operate to complement scale economies in the smaller size classes for Canadian-owned plants.

Unrelated—There is no significant difference on the effects of *unrelated* for either foreign or Canadian-owned plants for the pooled sample (Table 6). When broken down by nationality and plant size, the impact on the probability of a control change of being in an industry different from a parent firm is higher for domestic plants in the larger size classes. The impact on foreign-owned plants is generally less than on Canadian-owned plants and there is only a small increase in the marginal effect across size classes. An increasing plant size magnifies the costs of experimentation failure that is associated with unrelated diversification; more so in the domestic sector than in the foreign sector.

Change in size (ΔRel_L)—On its own, when the sample is pooled, this variable is not significant (Table 5). When *foreign* is separated out (Table 6), the marginal effect for domestic plants becomes significantly positive and for foreign plants, it is significantly negative. For Canadian plants, the marginal effect of *change in size* increases across the first three quartiles, but becomes insignificant in the fourth quartile. The smaller domestic plants are more likely then, to be acquired after they have shown a growth spurt in market share. In contrast, the marginal effect of a *change in size* is negative for foreign plants, thereby indicating that this group better accords with the disciplinary or management-failure model of mergers.

Change in knowledge intensity (ΔRel_NL)—Pooled together, increases in *knowledge intensity* significantly increases the probability of ownership changes for both Canadian and foreign plants (Table 5). Knowledge intensity is an important asset which leads to control changes, however the marginal effects are largest for small Canadian plants, but smallest for largest foreign plants.

Change in wages (ΔRel_WR) —In the overall pooled sample, the *change in wages* is negative and weakly significant (Table 5). When we separate out foreign plants (Table 6), this disciplinary explanation is much more significant in the foreign sector. When the interactions are estimated across size classes (Table 7 and 8), the impact is seen to exist for all foreign size classes, but is larger and particularly significant in the first and second quartiles.

Industry wage and profitability (capital intensity)(Ind _WR and *Ind _PR)*—In the pooled sample, the characteristics that are industry signals of knowledge intensity of industry participants have a mainly positive impact in the domestic sector, when interaction terms are added (Table 6). For this group, the probability of takeover increases across size classes. Thus, the signal arising from these industry characteristics (high wage and capital intensity) increases for larger domestic plants. Exactly the opposite occurs for foreign plants. Industry signals then matter more for larger domestic plants, while they do not for the foreign sector.

Foreign Effect--The impact of being foreign on the probability of a merger was previously shown (Table 5) to be positive and increase across size classes, a conclusion reached by assuming similarity in all marginal effects of the continuous variables. In the formulations presented in Tables 6, 7 and 8, inferences about differences must consider both the intercept and all of the interaction terms (evaluated at the mean). We report the net effect of being a foreign plant for each size group, which is calculated after taking into account differences in all other characteristics. Overall, the net effect of being foreign is 4.7% (Table 6), much larger than when the impact of nationality was being calculated only as an intercept term (1.3%) (Table 5). The net marginal effect for being foreign owned is 4.1% in the first quartile, 3.8% in the second quartile, 3.4% in the third and 3.2 % in the fourth quartile, the largest plant-size class. The results for the third and fourth quartiles are not significantly different from one another. These predicted differences between the intensity of foreign and domestic plant-control changes are close to the actual differences (first row, Table 9). After controlling for differences in the other covariates, being foreign owned captures the largest part of differences in the probability of plant-control changes between the foreign and domestic sectors. For instance, in the smallest plant-size class, the incidence of plant control changes for Canadian-owned plants is 0.5%, and for foreign-owned plants, 5.9% (5.4 percentage points higher) (Table 2). After taking into account the differences in characteristics between Canadian- and foreign-owned plants and the difference in the effect of continuous variables, being foreign-owned increases the probability of takeover by 4.1 percentage points, an increase that accounts for the majority of difference in the probability of control changes between foreign- and Canadian-owned plants. A similar result is found for other plant-size classes. These are all considerably different from the impact of

nationality that arises from the assumption that nationality only affects the probability of a control change through an intercept shift (second row, Table 9). Most of the differences in the intensity of a control change occur because of the difference in the determinants of control change across the foreign and domestic sectors, as well as the differences in their characteristics. Foreign plants differ considerably from domestic plants across all four size classes with respect to those characteristics that capture potential synergies (Table 3).

6 Conclusion

Our earlier paper (Baldwin, Gibson and Wang, 2009) asked whether it was synergies or managerial discipline that operates to affect the likelihood of mergers. It found that both are important. This paper examines the issue in more detail by asking two questions that enable us to determine whether these forces are at work equally in different parts of the firm distribution, or whether there is a discernible pattern suggesting systematic differences between large and small size classes. This serves to shed light on why the probability of control change is higher in larger firms.

The first question we investigate is whether the variables capturing synergies operate only in some parts of the size distribution. Our findings indicate that, overall, regardless of plant size, those characteristics which provide the type of synergy upon which ownership changes rely are important factors leading to plant-ownership changes across most size classes. The magnitudes, however, are different across plant-size classes.

The impact of plant size across the smallest three quartiles is about the same. This means that as plant size increases in each of these size groups, the probability of takeover continues to increase monotonically. The second variable (the importance of knowledge workers), also increases continuously across all plant-size groups. In both of these cases, the impact tends to increase across size classes more for domestic than for foreign plants. The specific competencies associated with knowledge workers are relatively more important generally in larger domestic firms than in smaller domestic ones. The third variable that is taken as a proxy for competency (*age*) also increases in magnitude—having a negative impact on the smallest size groups and a positive impact on the largest size group.

The majority of the industry-level covariates that act as general signals indicating the presence of synergistic capabilities in industry participants (that will allow acquired plants to ingest new knowledge from their acquirers), are found to generate persistent effects across the four plant-size classes. Industry knowledge capital, human capital intensity and industry profitability/capital intensity all provide additional synergy for plant takeovers, regardless of plant-size groups. The importance of these characteristics often increases across size classes. These variables provide only rough directional signals since they are provided for all firms within an industry. When these signals are used by acquiring firms to find plants that provide the type of capacity permitting successful knowledge transfer, it is the larger plants within these industries that are sought by acquirers.

In addition to the factors related to synergies, several other characteristics, less directly connected to synergistic knowledge capabilities, reinforce the tendency for a higher probability of control changes in large producers. The first is the impact of being an unrelated plant, which increases over size classes. This is less likely to be related to synergies and more likely to be related to costs of experimentation undertaken by some firms as they grow. Unrelated diversification is risky because firms doing so move into new markets and become exposed to new technologies—all of which leads to higher failure rates. It is possible, of course, that this

factor is also related to knowledge intensity in an indirect manner. Unrelated diversification has informational requirements needed to adapt to different markets and technologies. Larger firms have developed these capabilities because of their superior abilities to collect, assess and use information. This may lead larger firms to experiment more with unrelated diversification.

The second factor that is less obviously related to synergies that contribute to a higher probability of turnover, is the impact of the number of producers—the competitive environment. Here, the impact of the number of producers on the probability of a change in control gets larger for larger plant-size groups. That is, the probability of a control change is higher for larger plants than for smaller plants in industries with fewer producers. If control changes are more likely than greenfield plant construction to be used as a form of entry into industries with fewer producers because of the competitive environment, it is done by acquiring the larger plants in these industries. But even here, this may be related to the synergies available in larger plants in the form of technologies and plant size, which enables the exploitation of scale or scope economies.

The second question that we pose in this paper is whether there are systematic differences between domestic and foreign plants that suggest different forces are at work in the two populations.

We find that foreign plants in all size classes are more likely to be taken over, which accords with the hypothesis that foreign-owned plants contain more of the type of intangible assets that facilitate the knowledge transfer. The effective rates of control change differ much more in the small than in the larger size classes—thereby suggesting that multinational plants in these size classes contain relatively more of the type of intangible capital that make them attractive vehicles for the transmission of new knowledge via takeover. This occurs because of significantly larger differences in the synergistic characteristics of smaller foreign and domestic plants.

There are also significant differences in the manner in which some of the proxies for these synergies impact on the probability of a takeover between the foreign and domestic populations. Plant age has a negative coefficient for smaller domestic plants, but a positive coefficient for large plants (whereas the opposite is true for foreign plants).

Unrelated plants which are not core to their parents' major business, are more likely to be divested in domestic plants than in the foreign segment, but more so for the largest segment. This is because the divestiture rate associated with being unrelated increases across size classes for domestic plants, but not for foreign plants. An increasing plant size magnifies the costs of experimentation failure associated with unrelated diversification (mainly so in the domestic sector).

Declines in market share and wages, particularly in the intermediate size classes are related to takeover in the foreign sector, but not in the domestic sector—a finding that accords with the suggestion that foreign operations are more likely to respond to managerial failure by being divested.

In contrast to this profile, domestic plants are more likely to be divested if they are younger and have had a growth spurt in sales. Divestiture here appears to be related more to a process that harvests success at an early stage of life by the divesting plant.

In conclusion, dividing the population into different groups—by size class and nationality—serves two separate purposes. By showing the differences across size classes, it reinforces the interpretation that larger firms embody special characteristics that engender a higher propensity

for takeovers. Second, it emphasizes the origin of the differences that arise between the domestic and foreign population: the higher probability of control changes in the foreign sector is related to differences in knowledge capital and performance thresholds.

Breaking down the sample of foreign plants reveals that the impacts of some of the synergistic variables are even larger than the pooling of both domestic and foreign plants suggests—partially because they tend to come more from one sector than another and partially because pooling the two together dampens the overall results. This is particularly the case with the variables that measure the impact of changes in market share and wage rates.

Finally, these results also show that some of the impacts differ substantially across size classes (for example, plant age, and industry knowledge intensity signals), helping to explain why studies with different partial population samples may be expected to report results that are at variance with one another. The change variables that should be associated with a disciplinary impact operate more intensively in smaller size classes. This emphasizes the importance of having comprehensive samples to explore the determinants of mergers.

Table 1
Importance of foreign ownership and control changes by plant-size class, 1973 to 1999

	Value of shipments	Value added	Production workers' wages	Non-production workers' wage
		percent		
Foreign share				
First quartile	44.19	43.21	34.38	42.78
Second quartile	43.91	43.06	34.25	42.73
Third quartile	44.01	43.14	34.29	42.73
Fourth quartile	44.00	43.13	34.29	42.73
Total sample	44.01	43.16	34.17	42.58
Ownership changes in all plants				
First quartile	5.62	5.47	5.30	5.73
Second quartile	5.66	5.54	5.40	5.90
Third quartile	5.74	5.63	5.49	5.97
Fourth quartile	5.84	5.74	5.57	6.10
Total sample	5.77	5.66	5.50	6.01
Ownership changes in foreign-owned plants				
First quartile	6.42	5.95	6.38	6.20
Second quartile	6.59	6.26	6.70	6.59
Third quartile	6.35	6.07	6.50	6.40
Fourth quartile	6.45	6.28	6.72	6.65
Total sample	6.45	6.19	6.63	6.55
Ownership change in Canadian-owned plants				
First quartile	5.55	5.41	4.99	5.62
Second quartile	5.62	5.46	5.04	5.73
Third quartile	5.80	5.67	5.24	5.92
Fourth quartile	5.91	5.77	5.31	6.03
Total sample	5.81	5.66	5.22	5.92

Table 2
Incidence (observations) of foreign-owned plants by plant-size class, 1973 to 1999

	First quartile	Second quartile	Third quartile	Fourth quartile	Total
			number		
Ownership					
Domestic	103,711	94,783	90,307	77,736	366,537
Foreign	4,295	8,002	13,326	24,289	49,912
Total sample	108,006	102,785	103,633	102,025	416,449
			percent		
Foreign ownership	3.98	7.79	12.86	23.81	11.99
			number		
Control changes					
All control changes	739	1,420	2,519	4,761	9,439
			percent		
Plant/year control changes					
Total sample	0.68	1.38	2.43	4.67	2.27
Canadian-owned plants	0.47	0.99	1.87	3.87	1.67
Foreign-owned plants	5.87	6.06	6.23	7.22	6.65

Table 3
Differences between foreign and Canadian plants by plant-size class

Variable	Canadian	Foreign	Difference = foreign minus Canadian	Difference is different from 0?
		mean values		
Relative plant size				
First quartile	0.2830	0.4590	0.1760	Yes
Second quartile	0.8630	1.0233	0.1603	Yes
Third quartile	2.0370	2.3340	0.2970	Yes
Fourth quartile	7.9370	10.0590	2.1220	Yes
Total sample	2.4880	5.6940	3.2060	Yes
Relative human capital				
First quartile	0.2520	0.8090	0.5570	Yes
Second quartile	0.4070	0.9710	0.5640	Yes
Third quartile	0.6670	1.0530	0.3860	Yes
Fourth quartile	1.0100	1.1790	0.1690	Yes
Total sample	0.5540	1.0800	0.5260	Yes
Number of products				
First quartile	1.1230	1.5250	0.4020	Yes
Second quartile	1.2780	1.7600	0.4820	Yes
Third quartile	1.6400	2.0560	0.4160	Yes
Fourth quartile	2.1960	2.6520	0.4560	Yes
Total sample	1.5180	2.2520	0.7340	Yes

Table 4
Mean comparison between plants with ownership change (OC) and plants without ownership change

	Domestic-owned plants			Foreign owned plants			
	No OC (1)	With OC (2)	Is (2) significantly different from (1)?	No OC (3)	With OC (4)	Is (3) significantly different from (4)?	Is (4) significantly different from (2)?
	mean			mean			
Variables							
Plant knowledge intensity	0.54714	1.01387	Yes	1.07592	1.14106	Yes	Yes
Plant size	2.43223	5.80354	Yes	5.67927	5.91457	No	No
Plant number of products	1.50636	2.21462	Yes	2.24541	2.35824	Yes	Yes
Plant age	10.21261	13.11184	Yes	14.38715	15.12471	Yes	Yes
Plant age for older plants	24.06918	25.22072	Yes	24.70538	24.84175	No	Yes
Unrelated plant binary variable	0.02808	0.14090	Yes	0.20330	0.25836	Yes	Yes
Change in plant knowledge intensity	-0.05925	-0.01363	Yes	-0.022628	-0.00797	Yes	No
Change in plant size	0.00009	0.00011	No	0.00010	-0.00006	Yes	Yes
Change in plant wage rate	0.00813	0.00271	Yes	0.00424	0.00009	No	No
Change in plant profit rate	-0.02571	-0.00556	No	-0.00095	-0.17299	Yes	No
Relative industry knowledge intensity	0.90593	1.03206	Yes	1.16683	1.17121	No	Yes
Relative industry plant size	0.89727	1.48489	Yes	1.77588	1.76953	No	Yes
Relative industry wage rate	0.89581	0.95834	Yes	0.99838	0.98198	Yes	Yes
Relative industry profit rate	0.85142	0.92590	Yes	1.00164	0.99569	Yes	Yes
Diagnostic statistics							
Number of observations	360,419	6,118	...	46,591	3,321	...	...

Note: Variables are defined in Section 3.

Table 5
Differences in factors leading to ownership changes across plant-size classes

	First quartile		Second quartile		Third quartile		Fourth quartile		Total	
	coefficient	standard error	coefficient	standard error	coefficient	standard error	coefficient	standard error	coefficient	standard error
Variables										
Foreign binary variable	0.00890 **	0.00124	0.01192 **	0.00131	0.01086 **	0.00131	0.01513 **	0.00169	0.01308 **	0.00069
Plant size	0.00318 **	0.00043	0.00364 **	0.00048	0.00380 **	0.00042	0.00048 **	0.00005	0.00041 **	0.00002
Plant knowledge intensity	0.00220 **	0.00019	0.00407 **	0.00033	0.00734 **	0.00053	0.00717 **	0.00100	0.00841 **	0.00024
Plant number of products	0.00034 **	0.00014	0.00041 *	0.00017	0.00041 †	0.00022	0.00044	0.00029	0.00077 **	0.00009
Plant age	-0.00005 †	0.00002	-0.00013 **	0.00004	-0.00002	0.00006	0.00006	0.00011	0.00029 **	0.00003
Plant age for older plants	-0.00001	0.00002	0.00003	0.00003	-5.81E-06	0.00005	0.00022 **	0.00008	0.00030 **	0.00002
Unrelated plant binary variable	0.00912 **	0.00162	0.01145 **	0.00176	0.01995 **	0.00215	0.03157 **	0.00249	0.02000 **	0.00105
Change in plant size	0.15140	0.09744	0.26516 †	0.13741	0.05001	0.17164	0.00832	0.19361	0.06181	0.07113
Change in plant knowledge intensity	0.00100 **	0.00026	0.00207 **	0.00051	0.00452 **	0.00083	0.00758 **	0.00146	0.00470 **	0.00039
Change in plant wage rate	-0.00067	0.00065	-0.00268 †	0.00142	-0.00200	0.00241	-0.00140	0.00426	-0.00190 †	0.00104
Change in plant profit rate	-0.00001	0.00002	-8.74E-07	0.00006	0.00006	0.00011	-0.00023 †	0.00014	-0.00004	0.00003
Number of plants in industry	-1.77E-06 **	3.38E-07	-6.10E-06 **	6.23E-07	-0.00001 **	8.98E-07	-9.67E-06 **	1.23E-06	-6.10E-06 **	3.76E-07
Relative industry plant size	0.00011 **	0.00004	0.00031 **	0.00008	0.00011	0.00016	-0.00007	0.00037	0.00027 **	0.00007
Relative industry knowledge intensity	0.00156 **	0.00040	0.00172 *	0.00070	0.00192 †	0.00116	0.00747 **	0.00208	0.00244 **	0.00056
Relative industry wage rate	0.00442 **	0.00082	0.00519 **	0.00146	0.01213 **	0.00239	0.00590	0.00445	0.00792 **	0.00116
Relative industry profit rate	0.00220 **	0.00088	0.00706 **	0.00154	0.01560 **	0.00254	0.01661 **	0.00465	0.00895 **	0.00123

	First quartile	Second quartile	Third quartile	Fourth quartile	Total
Diagnostic statistics					
Number of observations	108,006	102,785	104,120	104,194	416,449
Pseudo R-squared	0.1808	0.1316	0.0944	0.0363	0.1009

* $p<0.05$
** $p<0.01$
† $p<0.10$
Notes: Variables are defined in Section 3. Results on constant, industry and year dummies are not reported because of space limitations. Some of the numbers in this table are followed by the letter E, which stands for exponent, a plus sign or a minus sign, and two digits that indicate the power of 10 by which the number is multiplied. This is a way to write numbers that accommodate values too large or too small to be conveniently written in decimal notation.

Table 6
Plant size, nationality and ownership changes, pooled sample

	Probit coefficients		Marginal effects	
	coefficient	standard error	coefficient	standard error
Variables				
Foreign binary variable	2.02075 **	0.07337	0.38391 **	0.02782
Plant size	0.01990 **	0.00071	0.00058 **	0.00002
Plant knowledge intensity	0.24526 **	0.00731	0.00716 **	0.00021
Plant age	0.00675 **	0.00088	0.00020 **	0.00003
Plant age for older plants	0.00718 **	0.00066	0.00021 **	0.00002
Plant number of products	0.02004 **	0.00303	0.00058 **	0.00009
Unrelated plant binary variable	0.47903 **	0.01919	0.02576 **	0.00154
Change in plant size	6.56741 **	2.45221	0.19165 **	0.07157
Change in plant knowledge intensity	0.13628 **	0.01147	0.00398 **	0.00033
Change in plant wage rate	-0.01677	0.03167	-0.00049	0.00092
Change in plant profit rate	-0.00005	0.00108	-1.48E-06	0.00003
Number of plants in industry	-0.00015 **	0.00001	-4.36E-06 **	9.56E-08
Relative industry plant size	0.00936 **	0.00252	0.00027 **	0.00007
Relative industry knowledge intensity	0.05790 **	0.01684	0.00169 **	0.00049
Relative industry wage rate	0.42036 **	0.03721	0.01227 **	0.00109
Relative industry profit rate	0.44652 **	0.03840	0.01303 **	0.00112
Foreign binary variable interacted with				
Plant size	-0.01939 **	0.00118	-0.00052 **	0.00011
Plant knowledge intensity	-0.17470 **	0.01533	0.00098	0.00157
Plant age	-0.00313 *	0.00159	0.00022	0.00016
Plant age for older plants	-0.00236 †	0.00125	0.00035 **	0.00012
Plant number of products	-0.01390 **	0.00532	0.00012	0.00051
Unrelated plant binary variable	-0.32590 **	0.02809	-0.00456	0.00307
Change in plant size	-13.6936 **	3.76585	-1.01340 **	0.33750
Change in plant knowledge intensity	-0.08320 **	0.02557	0.00214	0.00266
Change in plant wage rate	-0.13015 †	0.06790	-0.01645 *	0.00699
Change in plant profit rate	-0.00258	0.00195	-0.00030	0.00019
Relative industry plant size	-0.00732 †	0.00388	-0.00004	0.00035
Relative industry knowledge intensity	-0.01002	0.02932	0.00383	0.00296
Relative industry wage rate	-0.69335 **	0.05863	-0.04375 **	0.00564
Relative industry profit rate	-0.60933 **	0.06642	-0.03180 **	0.00651
Net marginal effects on being foreign	...	...	0.04647 **	0.00114

	Probit coefficients	Marginal effects
Diagnostic statistics		
Number of observations	416,449	416,449
R-squared	0.1009	0.1009

* $p<0.05$
** $p<0.01$
† $p<0.10$

Notes: Variables are defined in Section 3. Results on constant, industry and year dummies are not reported because of space limitations. Some of the numbers in this table are followed by the letter E, which stands for exponent, a plus sign or a minus sign, and two digits that indicate the power of .0 by which the number is multiplied. This is a way to write numbers that accommodate values too large or too small to be conveniently written in decimal notation.

Table 7
Plant size, nationality and factors leading to ownership change, first and second quartiles

	First quartile				Second quartile			
	Probit coefficients		Marginal effects		Probit coefficients		Marginal effects	
	coefficient	standard error	coefficient	sandard error	coefficient	sandard error	coefficient	standard error
Variables								
Foreign binary variable	2.15664 **	0.22660	0.24930 **	0.07117	2.13080 **	0.17586	0.34138 **	0.06401
Plant size	0.42058 **	0.05518	0.00310 **	0.00043	0.19033 **	0.02714	0.00314 **	0.00046
Plant knowledge intensity	0.25128 **	0.02151	0.00185 **	0.00017	0.21248 **	0.01806	0.00351 **	0.00030
Plant age	-0.01067 **	0.00328	-0.00008 **	0.00002	-0.00872 **	0.00232	-0.00014 **	0.00004
Plant age for older plants	-0.00468 †	0.00254	-0.00003 †	0.00002	-0.00021	0.00167	-3.43E-06	0.00003
Plant number of products	0.07296 **	0.01603	0.00054 **	0.00012	0.02750 **	0.01039	0.00045 **	0.00017
Unrelated plant binary variable	0.67232 **	0.06927	0.01307 **	0.00270	0.49146 **	0.05330	0.01496 **	0.00264
Change in plant size	29.52898 *	12.42519	0.21730 *	0.09193	19.50006 *	7.97558	0.32203 *	0.13208
Change in plant knowledge intensity	0.12713 **	0.03074	0.00094 **	0.00023	0.09642 **	0.02766	0.00159 **	0.00046
Change in plant wage rate	-0.02430	0.07865	-0.00018	0.00058	-0.07213	0.07909	-0.00119	0.00131
Change in plant profit rate	-0.00180	0.00224	-0.00001	0.00002	-0.00054	0.00336	-0.00001	0.00006
Number of plants in industry	-0.00017 **	0.00004	1.122E-6 **	3.01E-07	-0.00027	0.00003	-4.51E-06 **	2.88E-07
Relative industry plant size	0.01345 **	0.00531	0.00010 *	0.00004	0.01549 **	0.00500	0.00026 **	0.00008
Relative industry knowledge intensity	0.13264 **	0.04915	0.00098 **	0.00036	0.03879	0.03838	0.00064	0.00063
Relative industry wage rate	0.69450 **	0.10435	0.00511 **	0.00080	0.52491 **	0.08547	0.00867 **	0.00143
Relative industry profit rate	0.32044 **	0.10998	0.00236 **	0.00082	0.58487 **	0.08665	0.00966 **	0.00145
Foreign binary variable interacted with								
Plant size	-0.31154 **	0.09184	0.00694 *	0.00694	-0.06516	0.04639	0.00840 *	0.00366
Plant knowledge intensity	-0.16935 **	0.04913	0.00569	0.00409	-0.12868 **	0.03725	0.00422	0.00302
Plant age	0.02003 **	0.00566	0.00094 *	0.00043	0.00621	0.00413	-0.00009	0.00413
Plant age for older plants	0.01032 *	0.00491	0.00055	0.00039	0.00473	0.00320	0.00042 †	0.00025
Plant number of products	-0.16395 **	0.03670	-0.00891 **	0.00306	-0.01989	0.01723	0.00025	0.00128
Unrelated plant binary variable	-0.55650 **	0.10325	-0.00174	0.00837	-0.34199 **	0.07691	-0.00001	0.00655
Change in plant size	-49.91368 *	22.71214	-2.09389	1.75694	-25.28223 *	14.2496	-0.85528	1.09880
Change in plant knowledge intensity	-0.13267	0.08300	-0.00145	0.00711	0.01411	0.06320	0.00860 †	0.00526
Change in plant wage rate	-0.27808	0.18714	-0.02766 †	0.01565	-0.23209	0.16636	-0.02687 *	0.01356
Change in plant profit rate	-0.00082	0.00911	-0.00023	0.00081	0.00490	0.01320	0.00041	0.00118
Relative industry plant size	-0.00751	0.00827	0.00045	0.00060	-0.00432	0.00768	0.00077	0.00055
Relative industry knowledge intensity	0.09104	0.09346	0.01962 *	0.00828	0.08133	0.07097	0.01044 †	0.00586
Relative industry wage rate	-0.81981 **	0.17974	-0.01665	0.01397	-0.79897 **	0.14103	-0.03394 **	0.01091
Relative industry profit rate	-0.38320 †	0.21742	-0.00814	0.01744	-0.78449 **	0.16317	-0.02807 *	0.01303
Net marginal effect on being foreign	...	...	0.04104 **	0.00352	...	...	0.03769 **	0.00255

See notes at the end of the table.

Table 7 (concluded)
Plant size, nationality and factors leading to ownership change, first and second quartiles

	First quartile	Second quartile
Diagnostic statistics		
Number of observations	108,006	102,785
R-squared	0.1972	0.1411

* $p<0.05$
** $p<0.01$
† $p<0.10$
Notes: Variables are defined in Section 3. Results on constant, industry and year dummies are not reported because of space limitations. Some of the numbers in this table are followed by the letter E, which stands for exponent, a plus sign or a minus sign, and two digits that indicate the power of 10 by which the number is multiplied. This is a way to write numbers that accommodate values too large or too small to be conveniently written in decimal notation.

Table 8
Plant size, nationality and factors leading to ownership changes, third and fourth quartiles

	Third quartile				Fourth quartile			
	Probit coefficients		Marginal effects		Probit coefficients		Marginal effects	
	coefficient	standard error	coefficient	standard error	coefficient	standard error	coefficient	standard error
Variables								
Foreign binary variable	1.88795 **	0.14790	0.35454 **	0.05491	1.75392 **	0.11700	0.43822 **	0.04609
Plant size	0.11680 **	0.01187	0.00391 **	0.00040	0.01098 **	0.00086	0.00083 **	0.00007
Plant knowledge intensity	0.18973 **	0.01532	0.00635 **	0.00051	0.09120 **	0.01369	0.00690 **	0.00103
Plant age	-0.00312 †	0.00177	-0.00010 †	0.00006	0.00005	0.00147	4.12E-06	0.00011
Plant age for older plants	-0.00230 †	0.00133	-0.00008 †	0.00004	0.00200 †	0.00110	0.00015 †	0.00008
Plant number of products	0.00858	0.00633	0.00029	0.00021	0.00063	0.00404	0.00005	0.00031
Unrelated plant binary variable	0.44924 **	0.03811	0.02411 **	0.00301	0.35340 **	0.02638	0.03519 **	0.00331
Change in plant size	11.88453 **	5.20487	0.39773 *	0.17425	1.88584	2.88270	0.14274	0.21819
Change in plant knowledge intensity	0.12298 **	0.02312	0.00412 **	0.00077	0.09645 **	0.01909	0.00730 **	0.00144
Change in plant wage rate	-0.01220	0.06792	-0.00041	0.00227	0.00050	0.05700	0.00004	0.00431
Change in plant profit rate	0.00256	0.00335	0.00009	0.00011	-0.00136	0.00315	-0.00010	0.00024
Number of plants in industry	-0.00024	0.00002	-0.00001 **	8.13E-07	-0.00010 **	0.00001	-0.00001 **	1.87E-07
Relative industry plant size	0.00671	0.00509	0.00022	0.00017	0.00163	0.00572	0.00012	0.00043
Relative industry knowledge intensity	0.05759 †	0.03231	0.00193 †	0.00108	0.08824 **	0.02812	0.00668 **	0.00212
Relative industry wage rate	0.53815 **	0.07180	0.01801 **	0.00240	0.29519 **	0.06154	0.02234 **	0.00465
Relative industry profit rate	0.58620 **	0.07314	0.01962 **	0.00244	0.46904 **	0.06494	0.03550 **	0.00488
Foreign binary variable interacted with								
Plant size	-0.09532 **	0.02068	-0.00179	0.00180	-0.01216 **	0.00144	-0.00098 **	0.00016
Plant knowledge intensity	-0.07907 **	0.03102	-0.00458 †	0.00270	-0.06089 *	0.02434	-0.00299	0.00279
Plant age	0.00704 *	0.00316	0.00049 †	0.00027	-0.00108	0.00247	-0.00014	0.00029
Plant age for older plants	0.00678 **	0.00256	0.00052 *	0.00022	-0.00104	0.00190	-0.00003	0.00022
Plant number of products	0.00336	0.01161	0.00089	0.00099	0.00570	0.00678	0.00077	0.00077
Unrelated plant binary variable	-0.28919 **	0.05604	-0.00697	0.00562	-0.19942 **	0.03862	-0.01401 **	0.00529
Change in plant size	-31.31593 **	8.77957	-2.31645 **	0.72033	-5.48055	4.39047	-0.60635	0.47979
Change in plant knowledge intensity	-0.06084	0.04847	-0.00202	0.00428	-0.07392 †	0.03925	-0.00440	0.00465
Change in plant wage rate	-0.13929	0.13858	-0.01455	0.01214	-0.04564	0.10653	-0.00586	0.01239
Change in plant profit rate	-0.00315	0.00679	-0.00014	0.00059	-0.00160	0.00362	-0.00029	0.00033
Relative industry plant size	-0.01074	0.00810	-0.00062	0.00065	-0.00644	0.00838	-0.00074	0.00091
Relative industry knowledge intensity	-0.08490	0.05695	-0.00462	0.00498	-0.03874	0.04516	-0.00030	0.00516
Relative industry wage rate	-0.72268 **	0.11460	-0.03623 **	0.00951	-0.67484 **	0.09175	-0.07131 **	0.01032
Relative industry profit rate	-0.59483 **	0.12903	-0.02047 †	0.01098	-0.71520 **	0.10201	-0.06725 **	0.01146
Net marginal effect on being foreign	...	...	0.03435 **	0.00201	...	...	0.03231 **	0.00187

See notes at the end of the table.

Table 8 (concluded)
Plant size, nationality and factors leading to ownership changes, third and fourth quartiles

	Third quartile	Fourth quartile
Diagnostic statistics		
Number of observations	103,633	102,025
R-squared	0.0973	0.0442

* p<0.05
** p<0.01
† p<0.10
Notes: Variables are defined in Section 3. Results on constant, industry and year dummies are not reported because of space limitations. Some of the numbers in this table are followed by the letter E, which stands for exponent, a plus sign or a minus sign, and two digits that indicate the power of 10 by which the number is multiplied. This is a way to write numbers that accommodate values too large or too small to be conveniently written in decimal notation.

Table 9
Difference between foreign- and domestic-owned plants control changes by plant-size class

	First quartile	Second quartile	Third quartile	Fourth quartile	Total
			percent		
Incidence difference (Table 2)	5.4	5.1	4.4	3.4	5.0
Foreign effect (Table 4)	0.6	1.1	1.4	1.5	1.3
Net foreign effect (Tables 5, 6, 7)	4.1	3.8	3.4	3.2	4.7
Incidence difference minus net foreign effect	1.3	1.3	1.0	0.2	0.3

References

Bailey, M.N., C. Hulten and D. Campbell. 1992. "Productivity dynamics in manufacturing plants." *Brookings Papers on Economic Activity; Microeconomics 1992.* M.N. Bailey and C.M. Wilson (eds.). Washington, D.C. The Brookings Institution. p. 187–249.

Baldwin, J.R. 1992. "Industrial Efficiency and Plant Turnover in the Canadian Manufacturing Sector." *Industrial Efficiency in Six Nations.* R.E. Caves and S.D. Bailey (eds.). Cambridge and London. The MIT Press. p. 273–309.

Baldwin, J.R. 1995. *The Dynamics of Industrial Competition: A North American Perspective.* Cambridge. Cambridge University Press.

Baldwin, J.R., D. Beckstead and R.E. Caves. 2002. *Changes in the Diversification of Canadian Manufacturing Firms and Plants (1973-1997): A Move to Specialization.* Statistics Canada Catalogue no. 11F0019M. Ottawa. Analytical Studies Branch Research Paper Series. No. 179.

Baldwin, J.R., D. Beckstead and A. Girard. 2002. *The Importance of Entry to Canadian Manufacturing with an Appendix on Measurement Issues.* Statistics Canada Catalogue no. 11F0019M. Ottawa. Analytical Studies Research Paper Series. No 189.

Baldwin, J.R., and R.E. Caves. 1991. "Foreign multinational enterprises and merger activity in Canada." *Corporate Globalization Through Mergers and Acquisitions.* L. Waverman (ed.). Calgary (Alberta). University of Calgary Press. p. 89–122. Industry Canada Research Series. Vol. 2.

Baldwin, J.R., and G. Gellatly. 2005. *Global Links: Long-term Trends in Foreign Investment and Foreign Control in Canada, 1960 to 2000.* Statistics Canada Catalogue no. 11-622-M. Ottawa. The Canadian Economy in Transition. No. 8.

Baldwin, J.R., B. Gibson, and Y. Wang. 2009. *Control Changes in Canadian Manufacturing Plants: Disciplining Failure and Exploiting Synergies.* Ottawa. Economic Analysis (EA) Research Paper Series. Forthcoming.

Baldwin, J.R., and W. Gu. 2005. *Global Links: Multinationals, Foreign Ownership and Productivity Growth in Canadian Manufacturing.* Statistics Canada Catalogue no. 11-622-M. Ottawa. The Canadian Economy in Transition Series. No. 009.

Baldwin, J., and N. Rafiquzzaman. 1994. *Structural Change in the Canadian Manufacturing Sector, 1970-1990.* Statistics Canada Catalogue no. 11F0019M. Ottawa. Analytical Studies Branch Research Paper Series. No. 61.

Caves R.E. 1996. *Multinational Enterprise and Economic Analysis.* 2nd edition. Cambridge (United Kingdom). Cambridge University Press.

Caves, R.E. 1998. "Industrial organization and new findings on the turnover and mobility of firms," *Journal of Economic Literature*. Vol. 36. No. 4. p. 1947–1982.

Christensen, L.R., D. Cummings and D.W. Jorgenson. 1981. "Relative productivity levels, 1947-73: An international comparison." *European Economic Review*. Vol. 16. No. 1 p. 61–94.

Conyon, M.J., S. Girma, S. Thompson and P.W. Wright. 2002. "The productivity and wage effects of foreign acquisition in the United Kingdom." *Journal of Industrial Economics*. Vol. 50. No. 1. p. 85–102.

Dhrymes, P., and E. Bartlesman. 1992. *Productivity Dynamics: U.S. Manufacturing Plants, 1972–1986*. U.S. Census Bureau Center for Economic Studies Working Paper. No. CES-WP-92-1.

Doms, M.E., and J.B. Jensen. 1998. "Comparing wages, skills, and productivity between domestically and foreign-owned manufacturing establishments in the United States." *Geography and Ownership as Bases for Economic Accounting*. R.E. Baldwin, R.E. Lipsey and J.D. Richardson (eds.). Chicago. University of Chicago Press. p. 235–258. NBER Book Series Studies in Income and Wealth. Vol. 59.

Lecraw, D.J. 1984. "Diversification strategy and performance." *Journal of Industrial Economics*. Vol. 33. No. 2. p. 179–198.

Lichtenberg, F.R., and D. Siegel. 1987. "Productivity and changes in ownership of manufacturing plants." *Brookings Papers on Economic Activity*. Special Issue. No. 3. p. 643–674.

Lichtenberg, F.R., and D. Siegel. 1990. "The effects of leveraged buyouts on productivity and related aspects of firm behavior." *Journal of Financial Economics*. Vol. 27. No. 1. p. 165–194.

Lichtenberg, F.R., and D. Siegel. 1992. "Productivity and changes in ownership of manufacturing plants." *Corporate takeovers and productivity*. F.R. Lichtenberg (ed.). p. 25–43. Cambridge (Mass.). The MIT Press

Matsusaka, J.G. 1993a. "Target profits and managerial discipline during the conglomerate merger wave." *Journal of Industrial Economics*. Vol. 41. No. 2. p. 179–189.

Matsusaka, J.G. 1993b. "Takeover motives during the conglomerate merger wave." *RAND Journal of Economics*. Vol. 24. No. 3. p. 357–379.

McGuckin, R.H., and S.V. Nguyen. 1995. "On productivity and plant ownership change: New evidence from the longitudinal research database." *RAND Journal of Economics*. Vol. 26. No. 2. p. 257–276.

McGuckin, R.H., S.V. Nguyen and A.P. Reznek. 1998. "On measuring the impact of ownership change on labor: Evidence from U.S. food-manufacturing plant-level data." *Labor Statistics Measurement Issues*. J. Haltiwanger, M.E. Manser and R. Topel (eds.). p. 207–248. Chicago. University of Chicago Press. NBER Book Series Studies in Income and Wealth. Vol. 60.

Meade, J.E. 1968. "Is 'The new industrial state' inevitable?" *Economic Journal*. Vol. 78. No. 310. p. 372–392.

Nguyen, S.V., and M. Ollinger. 2006. "Mergers and acquisitions and productivity in the U.S. meat products industries: Evidence from the micro data." *American Journal of Agricultural Economics*. Vol. 88. No. 3. p. 606–616.

Norton, E.C., H. Wang and C. Ai. 2004. "Computing interaction effects and standard errors in logit and probit models." *The Stata Journal*. Vol. 4. No. 2. p. 154–167.

Olley, S.G., and A. Pakes. 1996. "The dynamics of productivity in the telecommunications equipment industry." *Econometrica*. Vol. 64. No. 6. p. 1263–1297.

Takii, S. 2004. "Productivity differentials between foreign and local plants in Indonesian manufacturing, 1995." *World Development*. Vol. 32. No. 11. p. 1957–1969.

ECONOMIC ANALYSIS (EA) RESEARCH PAPER SERIES Catalogue 11F0027

No. 001 *A Comparison of Canada-U.S. Economic Growth in the Information Age, 1981-2000: The Importance of Investment in Information and Communication Technologies*, ***Philip Armstrong, Tarek M. Harchaoui, Chris Jackson and Faouzi Tarkhani (March 1, 2002)***

No. 002 *Purchasing Power Parity: A Canada/U.S. Exploration*, ***Beiling Yan (May 2002)***

No. 003 *The Trend to Smaller Producers in Manufacturing: A Canada/U.S. Comparison*, ***John Baldwin, Ron S. Jarmin, Jianmin Tang (May 2002)***

No. 004 *Foreign Affiliate Trade Statistics – 1999: How Goods and Services are Delivered in International Markets*, ***Balance of Payments Division, Colleen Cardillo (April 2002)***

No. 005 *Regional Manufacturing Employment Volatility in Canada: The Effects of Specialization and Trade*, ***John Baldwin and W.Mark Brown (April 11, 2003)***

No. 006 *Growth History, Knowledge Intensity and Capital Structure in Small Firms*, ***G. Gellatly, S. Thornhill, A. Riding (August 6, 2003)***

No. 007 *Accounting for Greenhouse Gases in the Standard Productivity Framework*, ***Tarek Harchaoui, Dmitry Kabrelyan and Rob Smith (November 1, 2002)***

No. 008 *Overcoming Distance, Overcoming Borders: Comparing North American Regional Trade*, ***W. Mark Brown (April 16, 2003)***

No. 009 *Assessing the Impact of Greenhouse Gas Emissions on Canada's Productivity Growth, 1981-1996: An Expermental Approach*, ***Tarek M. Harchaoui and Pierre Lasserre (November 1, 2002)***

No. 010 *A Frontier Approach to Canada-U.S. Multifactor Productivity Performance*, ***Kaïs Dachraoui, Tarek M. Harchaoui (April 3, 2003)***

No. 011 *Participation in Export Markets and Productivity Performance in Canadian Manufacturing*, ***John R. Baldwin, Wulong Gu (August 13, 2003)***

No. 012 *Impact of Advanced Technology Use on Firm Performance in the Canadian Food Processing Sector*, ***John R.Baldwin, David Sabourin and David Smith (June 3, 2003)***

No. 013 *Foreign Affiliate Trade Statistics – Canadian Operations Abroad, 1999 to 2001-* ***Balance of Payments Division, by Michael Marth (May 2003)***

No. 014 *The Effect of Tariff Reductions on Firm Size and Firm Turnover in Canadian Manufacturing*, ***Wulong Gu, G.Sawchuk, L.Whewell (August 19, 2003)***

No. 015 *The Sources of Growth of the Canadian Business Sector's CO2 Emissions, 1990-1996*, ***by Kaïs Dachraoui, Gerry Gravel, Tarek M. Harchaoui and Joe St. Lawrence (September 2003)***

No. 016 *The Impact of Self-employment on Labour Productivity Growth: A Canada and United States Comparison*, ***John R. Baldwin, James Chowhan (August 21, 2003)***

No. 017 *Public Capital and Its Contribution to the Productivity Performance of the Canadian Business Sector*, ***Tarek M. Harchaoui and Faouzi Tarkhani (November 12, 2003)***

No. 018 *Prosperity and Productivity: A Canada-Australia Comparison*, ***Tarek M. Harchaoui, Jimmy Jean and Faouzi Tarkhani (December 9, 2003)***

No. 019 *Hollowing-out, trimming-down or scaling-up? An Analysis of head Offices in Canada, 1999-2002*, ***John Baldwin, Desmond Beckstead and W. Mark Brown (December 8, 2003)***

No. 020 *The Effect of Changing Technology Use on Plant Performance in the Canadian Manufacturing Sector*, ***John Baldwin and David Sabourin (July 27, 2004)***

No. 021 *Industrial Competition, Shifts in Market Share and Productivity Growth.* **John Baldwin and Wulong Gu (July 22, 2004)**

No. 022 *Innovation, Survival and Performance of Canadian Manufacturing Plants,* **John Baldwin and Wulong Gu (September 2004)**

No. 023 *Renewing Canada's Manufacturing Economy: A Regional Comparison, 1973-1996,* **W. Mark Brown (October 21, 2004)**

No. 024 *Catching Up and Falling Behind: The Performance of Provincial GDP per Capita from 1990 to 2003,* **John R. Baldwin, W. Mark Brown, Jean-Pierre Maynard, Danielle Zietsma (November 9, 2004)**

No. 025 *Whatever Happened to Canada-U.S. Economic Growth and Productivity Performance in the Information Age?* **Tarek M. Harchaoui and Faouzi Tarkhani (November 23, 2004)**

No. 026 *Water Use, Shadow Prices and the Canadian Business Sector Productivity Performance,* **Kaïs Dachraoui and Tarek M. Harchaoui (December 1, 2004)**

No. 027 *Trade Liberalization: Export-market Participation, Productivity Growth and Innovation,* **John Baldwin and Wulong Gu (December 14, 2004)**

No. 028 *A Comparison of Canadian and U.S. Productivity Levels: An Exploration of Measurement Issues,* **John R. Baldwin, Jean-Pierre Maynard, Marc Tanguay, Fanny Wong and Beiling Yan (January 20, 2005)**

No. 029 *Integration and Co-integration: Do Canada-U.S. Manufacturing Prices Obey the 'Law of One Price'?,* **André Bernard, Paul Warren and Beiling Yan (February 15,, 2005)**

No. 030 *Profitability of Canadian- versus U.S.-Controlled Enterprises,* **Paul Warren (March 3, 2005)**

No. 031 *Responses to Trade Liberalization: Changes in Product Diversification in Foreign- and Domestic-Controlled Plants,* **John R. Baldwin, Richard Caves and Wulong Gu (March 24, 2005)**

No. 032 *Canada's Investments in Science and Innovation: Is the Existing Concept of research and Development Sufficient?,* **John R. Baldwin, Desmond Beckstead and Guy Gellatly (April 12, 2005)**

No. 033 *Death in the Industrial World: Plant Closures and Capital Retirement,* **John R. Baldwin (May 4,, 2005)**

No. 034 *Foreign Multinationals and Head Office Employment in Canadian Manufacturing Firms,* **John R. Baldwin and W. Mark Brown (June 8, 2005)**

No. 035 *Demand for Skills in Canada: The Role of Foreign Outsourcing and Information-Communication Technology,* **Beiling Yan (October 28, 2005)**

No. 036 *Trade Credit and Credit Rationing in Canadian Firms,* **Rose Cunningham (November 4, 2005)**

No. 037 *Key Indicators in Canada,* **Paul Warren (November 30, 2005)**

No. 038 *The Impact of Trade on Plant Scale, Production-Run Length and Diversification,* **John R. Baldwin and Wulong Gu (May 19, 2006)**

No. 039 *How are Canadian Regions Adjusting to a Larger and More Integrated North American Market?,* **Wulong Gu and Gary D. Sawchuk (May 31, 2006)**

No. 040 *A Proposal for Treating Research and Development as Capital Expenditures in the Canadian SNA,* **Meir Salem and Yusuf Siddiqi (June 29, 2006)**

No. 041 *Exchange Rate Cycles and Canada–U.S. Manufacturing Prices,* **John R. Baldwin and Beiling Yan (June 28, 2006)**

No. 042 *Competition, Firm Turnover and Productivity Growth,* **John R. Baldwin and Wulong Gu, (September 25, 2006)**

No. 043 *Domestic and Foreign Influences on Canadian Prices over Exchange Rate Cycles, 1974 to 1996,* **John R. Baldwin and Beiling Yan, (November 8, 2006)**

No. 044 *The Ebb and Flow of Comparative Advantage: Trade and the Industrial Specialization of Canadian Manufacturing Regions, 1974 to 1999,* **W. Mark Brown (June 25, 2007)**

No. 045 *Urban Economies and Productivity*, **John R. Baldwin, Desmond Beckstead, W. Mark Brown and David L. Rigby (June 18, 2007)**

No. 046 *Real GDP and the Purchasing Power of Provincial Output*, **Ryan Macdonald (July 24, 2007)**

No. 047 *Estimating TFP in the Presence of Outliers and Leverage Points: An Examination of the KLEMS Datase*, **Ryan Macdonald (December 5, 2007)**

No. 048 *Canadian and U.S. Real Income Growth Pre and Post 2000: A Reversal of Fortunes*, **Ryan Macdonald (November 22, 2007)**

No. 049 *Agglomeration Economies: Microdata Panel Estimates from Canadian Manufacturing*, **John R. Baldwin, W. Mark Brown and David L. Rigby (February 5, 2008)**

No. 050 *An Examination of Public Capital's Role in Production*, **Ryan Macdonald (April 15, 2008)**

No. 051 *Trade Liberalization and Productivity Dynamics: Evidence from Canada*, **Alla Lileeva (May 7, 2008)**

No. 052 *Geographic Market Access and the Effects of Trade on Length of Production Run, Product Diversity and Plant Scale of Canadian Manufacturing Plants, 1974 to 1999*, **John R. Baldwin, W. Mark Brown and Wulong Gu (May 9, 2008)**

No. 053 *Firm Turnover and Productivity Growth in the Canadian Retail Trade Sector*, **by John R. Baldwin and Wulong Gu (December 8, 2008)**

No. 054 *Adapting to Import Competition: Effects of Low-wage Trade on Commodity Mix in Canadian Manufacturing Plants*, **John R. Baldwin and Alla Lileeva (May 16, 2008)**

No. 055 *Outsourcing and Offshoring in Canada: Trends, Causes and Economic Impact*, **John R. Baldwin and Wulong Gu (May 23, 2008)**

No. 056 *Plant Divestitures and Acquisitions in the Canadian Manufacturing Sector*, **John R. Baldwin, Robert Gibson and Yanling Wang (June 4, 2009)**

No. 057 *The Canadian Manufacturing Sector: Adapting to Challenges*, **John R. Baldwin and Ryan Macdonald (July 2009)**

No. 058 *PPPs: Purchasing Power or Producing Power Parities?*, **John Baldwin and Ryan Macdonald (December 2009)**

No. 059 *Real Gross Domestic Income, Relative Prices and Economic Performance Across the OECD*, **Ryan Macdonald (January 2010)**